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Book Review

CLIMATIC CHANGE AND GLOBAL WARMING OF INLAND WATERS: IMPACTS AND MITIGATION FOR ECOSYSTEMS AND SOCIETIES

Charles R. Goldman, Michio Kumagai, Richard D. Robarts (Eds.)

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The book *Climatic Change and Global Warming of Inland Waters. Impacts and Mitigation for Ecosystems and Societies* contains 26 contributions written by limnologists, hydrologists, modellers and environmental engineers, climate change biologists, fresh water ecologists, paleoclimatologists and students taking relevant courses within the Earth and environmental sciences. It is focused on a whole range of inland water habitats – lakes, running water, wetlands – offering novel and timely suggestions for future research, monitoring and adaptation strategies not only on the impact of climate change on freshwater ecosystems, but also frameworks and some pertinent suggestions for future management strategies and implementations. As was said into the preface written by three of the leading limnologists in the field, Charles R. Goldman – University of California, USA, Michio Kumagai – Ritsumeikan University, Japan, and Richard D. Robarts – World Water and Climate Foundation, Saskatoon, Canada (who are laso the book editors) "this volume provides excellent, concise exchanging science-based information on the current and future conditions of our limited surface freshwaters contained in the lakes and rivers of the world, combined with interesting details for each topic for the specialists".

The main discussed topics include considerations on the current and rapid climate change, especially rapid rate of warming (that has not occurred in the last 800,000 years, and was manifesting in the last decades). It is shown that some dominant factors exist, such as the continuous heat gaining by Earth during 2005-2010 marked by the strongest solar minimum recorded, and also the increasing amounts of methane, over 20 times as potent greenhouse gas as carbon dioxide (CO_2). Other important factors related to climate change are linked to major volcanic eruptions, various human activities, atmospheric aerosols, the feedback loop of water vapour rising from the warming oceans and also the dangerous effects or negative impacts of global warming on aquatic ecosystems causing rising of sea levels and damaging weather extremes.

The chapters are organized to describe the topics from Northern latitudes (*i.e.* Siberia, northern region bordering the Artic Ocean, Europe, Asia, and North America) to the more Southern regions (*i.e.* Africa, Middle East, South America, New Zeeland and Antarctica). They discussed the climatic changes associated with warming effects on lakes, rivers, wetlands, and their watersheds (*e.g.,* oxygen depletion in lakes, eutrophication stimulating the increasing of water temperatures) together with impacts of global warming on the society, with possible mitigation of negative impacts.

The impacts of climate change on our vital and limited surface waters differ greatly in specific regions of the world, affecting also the quality and treatment of drinking water and food supplies.

Climate change is altering the balance of rain, floods, and droughts together with our water-dependent food supplies that are essential to feed an increasing world population.

The first two contributions of this book, entitled "*Climate Change Impacts on the Hydrology and Biogeochemistry of Arctic Rivers"and "Climate Impacts on Arctic Lake Ecosystems"* are summarising the physical-chemical and biological impacts of climate change on Arctic rivers and lakes, but also of existent and future changes in enormous number of large and small fresh water bodies found in the permafrost areas of the high Artic.

The following seventeen chapters cover presentations of some important climate change impacts on important lakes and rivers from all over the world such as:

- *Baikal Lake* – Russian Siberia, the oldest deepest lake in the world (*Chapter 3 – Trends in Hydrological and Hydrochemical Processes in Lake Baikal under Conditions of Modern Climate Change* – summarising the aspects of reduction of annual period and extent of ice cover and thickness),

- *Major Chinese Rivers* and their enormous watersheds – the *Yellow* and *Yangtze* Rivers (*Chapter 4 – Hydrological Analysis of the Yellow River Basin, China*, and *Chapter 5 – Water Resources under Climate Change in the Yangtze River Basin* – confirming the necessity to improve the global water resource management, of collecting accurate longer term data to prediction on floods and droughts etc.),

- *Biwa Lake* – the largest lake in Japan (*Chapter 6 – Biogeochemical Ecosystem Dynamics in Lake Biwa under Anthropogenic Impacts and Global Warming* - dealing with the human impacts on this lake, and additional stress of warming, *Chapter 7 – Eutrophication, Warming and Historical Changes of the Plankton Community in Lake Biwa during the Twentieth Century* - examining the changes in the plankton population as eutrophication consequences and others, *Chapter 8 – Numerical Simulation of Future Overturn and Ecosystem Impacts for Deep Lakes in Japan* - providing numerical simulations of deep Japanese lakes and their future mixing as warming increases their water column stability and their resistance to complete mixing, *Chapter 9 – Model Development to Evaluate the Impacts of Climate Change on Total Phosphorus Concentrations in Lakes* - predicting the potential future lake conditions),

- *Scandinavian lakes of Denmark* – some shallow phosphorus-rich Danish lakes (*Chapter 10 – Recent Climate-Induced Changes in Freshwaters in Denmark* - underlining the increasing importance of eutrophication control, domination of cyanobacteria as an warming effect, or of dinoflagellates in the deeper stratified lakes, and *Chapter 11 – Lake Phytoplankton Responses to Global Climate Changes* - extending the coverage to a wide range of other lake types from different climate zones of the world),

- *Mid-latitude lakes of Europe* – e.g. *Geneva Lake* or *Constance Lake* (*Chapter 12 – The Influence of Climate Change on Lake Geneva* - emphasizing on warming of these lakes and region, and prediction of more radical weather changes and progressive lake warming),

- *Canadian wetlands of the prairie Pothole region* (*Chapter 13 – Climate Change and Wetlands of the Prairie Pothole region of North America: Effects, Management and Mitigation*- examining the progressive warming of the wetlands in violent weather conditions, or the threat of drying these small wetlands if rainfall will significantly reduce here),

- *Western lakes of the United States* (California and Nevada) – e.g. *Tahoe Lake* – one of the world's clearest large lake (*Chapter 14 – Historic and Likely Future Impacts of Climate Change on Lake Tahoe, California-Nevada, USA* - underlining the progressive warming of lake, and also increasing of frequent floods, water shed erosion, sediment transport, and more frequent lowering of lake level below its natural rim, or *Chapter 15 – Our New Biological Future ? The Influence of Climate Change on the Vulnerability of Lakes to Invasion by Non-Native Species* - examining the changes of biota and associated food webs, increasing of vulnerability to invasion of non-native species or experiments of intentional and accidental introduction of Eurasian clam as a variety of warm-water fish),

- *Kinneret Lake* in Israel – an arid region with high water demands (*Chapter 16 – Long-Term Changes in the Lake Kinneret Ecosystem: The Effects of Climate Change and Anthropogenic Factors* - noting the change in domination of phytoplankton and serious cyanobacterial booms altering food web together with inputs of organic carbon and nitrogen from degraded wetland peat; the water demand for irrigation and municipal water supplies in this region is intense and threat of increasing salinity is always present; moreover, the recent reductions in rainfall are indicating the impacts of climatic change),

- *Amazon River* based on Varzia lakes along its flood plain (shallow lakes) (*Chapter 17 – Climate Change and the Foodplain Lakes of the Amazon Basin* - mentioning the altering of the dynamics of flooding caused by climate change)

- *African Great Lakes* in the famous Rift Valley – e.g. Victoria Lake or volcanic Nyos Lake (*Chapter 18 – Climatic Variability, Mizing Dynamics, and Ecological Consequences in the African Great Lakes* - concerning the faster heating of these great lakes having mixing dynamic influenced by wind and ocean mixing conditions, or volcan eruption impact causing the gassing and death of many local people and animals),

- *North Island lakes in New Zealand* – e.g. Taupo Lake and Rotorua Lake (*Chapter 19 – Effects of Climate Change on New Zealand Lakes* - considering no detectable warming in these lakes but less frequent mixing influenced of the surrounding ocean).

Another important contribution entitled "*Global Change Effects on Antarctic Freshwater Ecosystems: The Case of Maritime Antarctic Lakes*"

(*Chapter 20*) confirms major changes with loss of sea ice and penguin habitat in the extreme climate of Antarctica, a barren frozen land.

Some important societal aspects of water and climatic change are discussed in the following two chapers (*Chapter 21 – Adaptation to a Changing Climate in Northern Mongolia*, and *Chapter 22 – Managing the Effects of Climate Change on Urban Water Resources*). The situation of pasture lands of Mongolia (forced to changes that altered the availability of grazing and water supplies, and caused severe frequent sudden rainstorms) is analyzed. Also, some megacities are considered (confronted with challenge of managing water, sewage and solid wastes for an increasing number of inhabitants in order to maintain a reasonable quality of life in large cities).

Some recommendations for mitigating some of global challenges facing the planet warming are provided in *Chapter 23* – Water Management Preparation Strategies for Adaptation to Changing Climate, and *Chapter 24 – In Search of Strategies to Mitigate the Impacts of Global Warming on Aquatic Ecosystems*. An interesting technology for decomposing water into hydrogen and oxygen by electrolysis is reported in *Chapter 25 – Artificial Decomposition of Water into Hydrogen and Oxygen by Electrolysis to Restore Oxygen in Climate Change-Impacted Waters*, for application to the depths of lakes impacted by eutrophication and climatic warming.

The last contribution "*Summary and Conclussions"* by Michio Kumagai underlines the fact that many attempts are considered in the world to save inland waters from global warming on the basis of application the best solutions of mitigation and adaptation strategies. There are only few solutions possible to apply, and mainly consists in reduction of fossil fuel use and improvement of the management strategies for inland water ecosystems acting for potential reduction of temperature in aquatic habitats, modification of heat distribution, reduction of greenhouse gases etc.

The editors of this book have the merit to synthesize some real and critical points of view of some important specialists in the climate change and global warming of inland waters, confronted with serious increasing of water temperature in many lakes and rivers, shifts in freshwater flora and fauna, and the expansion of "dead" zones with low dissolved oxygen concentrations. The predictions of air temperature increasing by 2-4°C at the end of this century (Intergovernmental Panel on Climate Change 2007) have overpassed in the Far East for several decades being almost double, and causing many real problems in inland water ecosystems. Several authors in this books have suggested the necessity of performant monitoring systems based on good science to share information and data, management plans to protect and save the inland waters without fundamental support, and future effective action plans to remediate aquatic environments that have undergone damage.

This book is necessary to people working into various fields of environmental sciences, management and engineering, and for those interested in finding new actual information on climatic change and global warming in inland water ecosystems, summarizing the key issues for possible adaptation and mitigation approaches that may reduce serious risks of damaging these aquatic systems.

The book is a real representative one for environmental education, since it can assist students who are in the process of selecting an inspiring, relevant topic for their studies and later, their final research reports.

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